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SUMMARY

Paired cuts of beef, pork and lamb in the form of steaks or chops, ground meat and roasts, and corresponding portions of ham, bacon, sausage, dried beef and representative ready-to-serve meats (chicken loaf, boiled tongue, etc.) were stored for varying lengths of time, under a selected number of different storage conditions, in ice and mechanical refrigerators of the size commonly used in the home.

Greatest loss in weight occurred when the meat was stored uncovered; least loss, when wrapped in paraffin paper or stored in a covered container.

Fresh meat stored in a covered container showed signs of deterioration after 72 hours.

Adding salt during the storage period gave fresh meat a moist consistency and prevented the formation of a surface crust but increased the tendency to become slimy.

A moist atmosphere caused mold to form on cured meat; a dry atmosphere caused a deposit of the curing salts on the surface.

Care of Meat in the Household Refrigerator[1]

By Louise J. Peet

The objectives of the investigation were to determine (1) the loss in weight (shrinkage) of meat held for varying lengths of time in ice and mechanical refrigerators of a size commonly used in the home and (2) the storage conditions which are desirable in caring for meat in the household refrigerator.

Meat has an important place on the menu in the American home. In the packing plant and retail market an effort is made to maintain suitable refrigeration. After the meat reaches the home it is the housewife's responsibility to provide equally favorable conditions for its preservation. Meat shrinkage is a significant factor in commercial refrigeration and should be of interest to the homemaker since the shrinkage at home is relatively greater than in commercial refrigerators. This is because meat is purchased for the home in comparatively small amounts with a resulting high proportion of cut surface.

SIMILAR RESEARCH BY OTHER INVESTIGATORS

Most of the studies on the refrigeration of meat have been made in cold storage plants, but even here Moran found that improvements have been on the engineering side more than on the biological, although the latter considerations are the more important (15). If the physical conditions necessary for optimum refrigeration are to be obtained, the properties of food and the effect on these properties of humidity and temperature must be known. Moran noted that "with the breakdown of the living mechanism, meat is an excellent medium for the growth of molds and bacteria." He also observed that there was only a limited range of humidity in which molds would grow, so that if the temperature was sufficiently low to withdraw most of the moisture from the air the growth was inhibited. He found that an important problem was the prevention of rancidity in fat, since fat deteriorates rapidly at a high temperature. Lea (13) too found that changes in the fat more than other factors limited the period of meat storage. He believed that the changes were due not only to atmospheric oxidation of certain unsaturated constituents of the fat to compounds of disagreeable odor and flavor, but also to partial hydrolysis of

[1] Project 371 of the Iowa Agricultural Experiment Station.

the fat. Hoagland and his co-workers (10) discovered that this deterioration in the fat was caused by an increase in free fatty acids, which might explain the sour odor which Haines noticed in chilled meat after 5 days of storage (9).

Moran (15) recommended freezing the meat for long periods of storage. He found that while the appearance was somewhat affected there was no apparent change in the food value. Hard freezing was equivalent to a drying out process (16).

Moisture which forms after frozen meat is thawed makes the marketing of the meat difficult. Moran observed that some of the organic compounds, salts and pigments separated out and were lost on thawing. The latest investigations indicate that the amount of "drip" is not dependent upon the method of slow or rapid freezing but upon several factors, the most important being the pH of the meat. There is apparently a direct relationship between the pH and the capacity of the meat muscle to hold fluid. Birdseye considered the "drip" important because of its tendency to carry away nutritive substances and to leave a tasteless, dry product (1). He found that quick freezing reduced the bacterial content from 40 to 60 percent, and, consequently, frozen meat would keep longer at ordinary refrigerator temperatures than similar fresh products.

Similar results with slowly or partially frozen meats were obtained by Wright (22) who recommended that meats be held below —9°C. to prevent the growth of mold, if stored for any long period. He recorded instances of pork held for 9 years under carefully controlled temperature conditions without the formation of mold.

Haines (9) too noted the separation of proteins and salts from frozen meat and concluded that they gave an excellent medium for the growth of micro-organisms unless a low temperature was maintained. He emphasized the importance of humidity control because of the development of slime on the surface of meat in a too moist atmosphere. The odor was disagreeable, but of a "taint" type rather than putrefactive. Haines stated that —5°C. was not sufficiently low to prevent bacterial action. The handling which meat received before being placed in cold storage was also important.

The effect of freezing meat on the presence of vitamins A and B was investigated by Wright. He fed experimental animals with lamb which had been stored 3 years, beef stored 3 years and pork stored 9 years as sources of vitamins A and B and found that cold storage had neither destroyed nor apparently reduced the amount of the vitamins (23, 24).

Different humidities were used by Hoagland, McBryde and Powick (10). They compared the keeping qualities of beef stored at a humidity of 70 to 80 percent saturation and stored at 92 to 95 percent saturation when the temperature remained between 32° and 36°F. At the lower humidity the meat showed a shrinkage in weight and some darkening and hardening of the cut surfaces. This drying effect apparently inhibited the formation of mold, for at the higher humidity there was a heavy growth of mold, although the shrinkage was less. The molds and bacteria did not penetrate the meat to any distance, and even when the meat held for the longer periods acquired an "old" flavor it was judged wholesome by organoleptic tests, which included taste. The investigators concluded that the factors which determine the length of time beef can be stored are: initial condition, which includes fatness and finish, temperature and humidity.

Columbia University investigators (3, 6) decided that temperature was more important than relative humidity, since in their tests the effects of a low humidity were exceeded by the effects of a high temperature. They emphasized the need of storing food for as short a time as possible. Bowen also considered time a significant factor (4).

Lea (13) discovered that in addition to the changes in the fat tissue there was an oxidation of hemoglobin to brown methemoglobin in the surface layers of meat. Brooks (2) made a special study of this change and noted that the depth of the oxygen penetration diminished rapidly, so that the formation of the methemoglobin was confined to a relatively thin surface layer, a few millimeters in thickness. Alternate freezing and thawing increased the rate of methemoglobin production but did not affect the depth of the layer.

In several studies on home refrigerators the investigators included some tests on storage of meats. As a result of these tests, Danner (8) concluded that uncooked meat should not be placed in a tightly covered dish and on the other hand should not be left uncovered, because of the formation of the surface crust. She recommended wrapping the meat loosely in paraffin paper. After it is cooked the meat might be similarly wrapped or placed in a covered container. Danner also suggested wiping the meat with a damp cloth before storing it, but the Bureau of Home Economics (5) found this wiping tended to draw the meat juices and hasten spoilage. Containers should be as light in weight as possible to reduce the amount of refrigeration needed to cool the container. Both groups of investigators and also Jordan (12)

agreed that temperatures below 50°F. were necessary for the storage of meat.

Haines (20) pointed out the difficulty of storing meat for any length of time in the small refrigerator because of the large proportion of cut surface. He found that under the most favorable conditions lean beef could not be stored for longer than 3 weeks even at a temperature of 0°C. He concluded that humidity was an important factor in storing any food and varied with the type of food.

Pabst (17) made a bacteriological study of meat stored covered and uncovered in the home refrigerator. She used cubes of round steak and for her tests took samples from ten places on each cube. The results given in the following table, taken from her report, are an average of 24 series of tests.

EFFECT OF STORAGE TEMPERATURE UPON THE NUMBER OF BACTERIA IN MEAT.*

Temp. °F.	Original sample	Rate of increase in			
		24 hours	48 hours	72 hours	96 hours
Meat stored in uncovered containers					
35	2	1	2	4	4
40	2	3	3	5	11
45	2	5	20	143	1,301
50	2	12	92	2,929	9,145
55	2	21	3,356	22,261	97,294
Meat stored in covered containers					
35	2	3	2	7	8
40	2	3	4	24	221
45	2	11	32	2,083	4,894
50	2	32	137	7,420	24,197
55	2	32	4,525	18,879	390,130

*Pabst, A. M. Meat Keeping in Home Refrigerators Studied in Varying Conditions. Yearbook of Agriculture, p. 370, 1931.

Pabst noted that the covered container gave conditions which were equivalent to a 5-degree rise in temperature. She concluded that meat held for more than 24 hours should be stored below 50°F. and preferably below 45°F.; when held for more than 48 hours the temperature should be below 45° F. She suggested covering uncooked meat loosely, if at all, since the drying of the surface of uncovered meat retarded the development of bacteria. Cooked meat, however, should be covered loosely, since in this case the drying affected the palatability.

From the table it appears that the method of storage is immaterial when a temperature as low as 35°F. is maintained. Even at 40°F. the increase in the number of bacteria up to 72 hours is almost negligible regardless of method of storage, and meat may be kept covered or uncovered for 48 hours at 45°F. without a noticeable increase in the number of bacteria.

EQUIPMENT USED

1. Refrigerators:
   a. Electric refrigerator of approximately 6 cubic foot capacity.
   b. Ice refrigerator of approximately 6 cubic foot capacity, of a type in which the air circulates across only the bottom surface of the ice.
2. Milvoy double beam scales of 250 gram side beam capacity, weighing to .1 gram.
3. Six Waco "Perfect Roast" straight type meat thermometers.
4. Containers for storing meat:
   a. Two covered enamel pans, 13″x8.5″x4″, with six perforations, three on a side, for the circulation of air.
   b. Two covered glass dishes, 6″ in diameter x 4.5″ deep.
   c. Two covered aluminum dishes, 6″ in diameter x 5.5″ deep.
   d. Two covered glass dishes, 8″ in diameter x 5″ deep.
   e. Two covered aluminum dishes, 9.5″ in diameter x 5″ deep.
5. Gas and electric ranges of household size, equipped with oven regulators.

MEATS USED FOR TESTS

1. Beef:
   a. Round steaks.
   b. Loin steaks.
   c. Ground beef.
   d. Standing rib roasts.
   e. Boned and rolled rib roasts.
2. Pork:
   a. Chops.
   b. Ground pork.
   c. Loin roasts.
3. Lamb:
   a. Chops.
   b. Legs.
4. Cured meats and sausage:
   a. Ham:
      (1) Sliced.
      (2) Whole.
   b. Bacon:
      (1) Sliced.
      (2) Squares.
   c. Sausage:
      (1) In casings.
      (2) Bulk.
   d. Dried beef.
5. Ready-to-serve meats:
   a. Pressed chicken.
   b. Sliced ham (cured).
   c. Tongue.
   d. Spiced luncheon loaf.

GENERAL EXPERIMENTAL PROCEDURE

Temperatures in the food chambers of the refrigerators were recorded by means of Fahrenheit thermometers. Twenty-five cubic centimeter Erlenmeyer flasks were filled approximately three-fourths full of cooking oil and closed with a one-hole rubber stopper through which was inserted the thermometer so that the entire bulb was immersed in the oil. Three thermometers were placed in each refrigerator, one on the top shelf, one on the middle shelf and the third on the floor of the food chamber.

At no time did the temperature vary throughout the food chamber in either refrigerator by more than approximately 3 degrees. Table 1 gives typical readings for the three thermometers in the two refrigerators.

Usually the top shelf in the ice refrigerator and the middle shelf in the electric refrigerator were slightly cooler than the other sections of the food chambers.

TABLE 1. REFRIGERATOR AND ROOM TEMPERATURES (FAHRENHEIT).

Location of thermometer	Feb. 26		April 21		May 26	
	Ice	Elec.	Ice	Elec.	Ice	Elec.
Top shelf	48	44	46	42	46	39
Middle shelf	49	42	48	40	46	38
Bottom of chamber	49	45	49	43	48	41
Room	76	76	76	76	80	80

During the course of the investigation, the temperature in the ice refrigerator ranged from 45° to 52° F. with the most frequent temperature about 47°; in the electric refrigerator from 37° to 45° with the most frequent temperature 42°. The room temperature varied from 70° to 80° F. except during the experiments with ready-to-serve meats, when on several days the temperature was over 80° and one day as high as 86°. A constant temperature room was not available but the conditions of the experiment did not make this room necessary since constant temperatures do not prevail in the home. The two refrigerators were placed in the room in similar positions.

In all of the tests with beef, pork and lamb paired cuts from the animal carcass were used. The history and grading of the meat were known (appendix, table 22). One of the paired cuts was placed in the ice refrigerator and the other in the electric refrigerator.

In the experiments with cured and ready-to-serve meats, the entire supply for any one set of tests was purchased at one time and approximately equal weights were placed in each refrigerator.

In an attempt to determine a desirable method, the meat was stored in various ways—in glass containers, aluminum containers, enamelware containers, wrapped in paraffin paper, wrapped in a double covering of parchment and brown wrapping paper similar to the manner in which it would be received from the market, and left unwrapped. In some tests the unwrapped meat was wiped with a damp cloth before being placed in the refrigerator.

The smaller cuts were weighed every 24 hours to measure shrinkage; the larger cuts were weighed at 48- or 72-hour intervals and in the case of the hams and bacon squares only once in 4 or 5 days. With the exception of the roasts, daily samples were taken from approximately the same part of each cut of the fresh meat and were broiled under carefully controlled conditions, i.e., the broiler oven was preheated 10 minutes in each case and the samples broiled for the length

of time predetermined as best for the given kind of meat. Both the cooked and the uncooked meat were judged for color, appearance, odor and flavor. The organoleptic test of food products was considered by Sunderlin (21) to be reliable and a more frequent evidence of food spoilage than either chemical or bacteriological tests. For this reason and because it was the most convenient method, it was chosen for these experiments.

For convenience similar cuts of beef, pork and lamb will be considered together.

STEAKS AND CHOPS

The first tests were with round steaks. Six pairs of round steaks, 1½ inches thick, were stored in various containers, wrapped, or left unwrapped. They were weighed every 24 hours to measure shrinkage, samples were cooked, and the cooked and uncooked portions were judged by physical methods. Pork chops were used in a second series of tests and lamb chops in a third.

For a final series of tests, three pairs of loin steaks were used to determine the advisability of storing the meat within the sleeve of the freezing unit of the electric refrigerator, or in the pan directly beneath the unit. One pair was wrapped in parchment and brown butcher's paper, a second pair was placed in covered containers, and the third pair was left unwrapped. Each day the steaks were weighed and a portion cooked. Since the meat stored inside the freezing unit was frozen, the portion to be cooked was divided; one piece was cooked immediately, and the other piece was thawed first at room temperature.

To check on the time required to defrost frozen meat, paired steaks 1½ to 2 inches thick weighing between 2½ and 3 pounds and roasts approximately 6 pounds in weight were stored in the refrigerators until defrosting was complete. The average daily shrinkage losses of steaks and chops and the percentages of loss are given in tables 2 and 3.

The percentage of loss was not calculated directly from the initial weight for samples were cut each day from the steaks and chops for cooking. Consequently it was necessary to determine the percentage of shrinkage on the new weights obtained from day to day, and average them.

The daily sampling exposed a fresh surface which may have made the shrinkage greater than would have occurred had no samples been taken. The error in percentage of shrinkage from this cause was not estimated. All cuts of steaks and chops and portions of ground meat were treated in the same manner, so the results are comparative.

TABLE 2. AVERAGE DAILY SHRINKAGE OF STEAKS AND CHOPS IN ELECTRIC REFRIGERATOR.

Method of storing	Beef			Pork			Lamb		
	Initial wt.	Average daily loss		Initial wt.	Average daily loss		Initial wt.	Average daily loss	
	gm.	gm.	%	gm.	gm.	%	gm.	gm.	%
Parchment and brown paper	2053.7	28.10	1.63	484.4	5.94	1.84	321.8	4.64	2.12
Paraffin paper	1707.8	10.86	.74	452.1	2.36	.76	314.8	2.48	1.38
Covered aluminum dish	1336.3	2.65	.18	516.7	.62	.18	281.5	.36	.16
Covered glass dish	1003.3	2.36	.22	477.4	1.18	.31	358.4	.50	.30
Unwrapped	2449.2	42.20	2.35	503.8	8.46	2.64	324.8	7.22	3.60

TABLE 3. AVERAGE DAILY SHRINKAGE LOSSES OF STEAKS AND CHOPS IN ICE REFRIGERATOR.

Method of storing	Beef			Pork			Lamb		
	Initial wt.	Average daily loss		Initial wt.	Average daily loss		Initial wt.	Average daily loss	
	gm.	gm.	%	gm.	gm.	%	gm.	gm.	%
Parchment and brown paper	1975.2	23.35	1.51	529.2	6.78	1.88	242.6	4.54	2.77
Paraffin paper	1653.8	12.45	.76	504.1	2.12	.64	302.7	2.28	1.41
Covered aluminum dish	1282.8	2.19	.17	545.1	.80	.20	265.7	.075	.05
Covered glass dish	960.4	2.27	.27	525.8	.85	.22	288.9	.25	.12
Unwrapped	2158.0	41.49	2.26	530.2	8.26	2.44	321.7	7.72	3.72

In all of the tests the greatest percentage of shrinkage loss occurred in the sample left unwrapped. Following, in decreasing order, were the samples in parchment and brown wrapping paper, paraffin paper, covered glass container and covered aluminum container.

There was no definite relationship between the shrinkage of meat stored in the ice refrigerator and of that stored in the electric refrigerator. Sometimes greater loss occurred in one refrigerator, sometimes in the other. The greatest difference in any one test was .65 of one percent, and in 12 out of the 15 cases the difference was .12 of one percent or below, in eight cases being less than .1 percent.

Meat stored in covered containers for a period of 48 hours was juicy and of a fresh flavor when cooked, especially when stored below 45° F. After 48 hours meat stored covered acquired an odor which for want of a better description was called a "shut-in" odor. The meat stored in aluminum acquired this undesirable odor and flavor about 24 hours later

than the meat stored in glass. When cooked the samples also had a characteristic, somewhat smoky flavor which was not pleasing, although spoilage was not apparent. Moist surfaces tended to become slimy after 72 hours.

The meat left uncovered formed a hard leathery surface which darkened with the longer period of storage until it was almost black. The color, however, was improved by cooking. When these pieces were cooked they appeared to be much less rare than the covered and wrapped samples, although cooked at the same time under the same controlled conditions.

Wrapping meat in parchment and brown paper hindered the drying process somewhat, but the paper was sufficiently porous to allow considerable evaporation, as is noted in the tables of shrinkage losses. Moreover as the surface dried it tended to stick to the parchment paper, and the paper was removed with difficulty.

The samples wrapped in paraffin paper were the best. They were juicy, of a red color and desirable in odor and flavor. After 72 hours the samples stored at 42° F. or below gave least evidence of deterioration.

In the experiments with pork similar results were obtained, but not to the same degree. The covered and wrapped samples gradually lost their flavor and became tasteless. The uncovered samples did not form the hard dry surface noticeable on the beef but did lose their fresh flavor.

The results of tests with lamb were similar to those with beef and pork. In general the lamb chops showed signs of deterioration in a shorter time than the other meats and, regardless of method, were more desirable when stored below 45° F., if held for longer than 48 hours. The parchment paper was satisfactory to use with the lamb and also with the pork chops, since the meat did not tend to stick to it, and it was sufficiently porous to allow some slight circulation of air.

When steaks were frozen and stored within the freezing unit of the electric refrigerator, they were more palatable when placed in a covered container or wrapped in paraffin or parchment paper than when left uncovered, since they tended to absorb undesirable flavors from the circulating air. Tests indicated that steaks were juicier and of better flavor when cooked without first defrosting. The cooking period required was two to three times longer than for unfrozen meat. When the steak was defrosted before cooking, defrosting in the refrigerator rather than at room temperature seemed preferable, for rapid thawing caused a greater

Fig. 1. Methods of storing ground meat.

loss of juice. In the case of roasts, Cline found increased shrinkage in roasts of low initial temperature when cooked at the low oven temperatures now recommended (7). In this case the defrosting process was hastened, with consequent loss of juice, before the actual cooking process started. With steaks and chops of comparatively small mass, however, the defrosting and cooking were almost simultaneous.

Additional tests on the defrosting of steaks and roasts showed that a steak 2 to 3 pounds in weight and 1½ to 2 inches in thickness defrosted in 6 to 7 hours at a temperature between 45 and 50° F., and in about 12 hours at a temperature between 40 and 42° F. A 5- to 6-pound roast defrosted in about 20 hours at the higher temperature but required 26 to 28 hours when the temperature was 40 to 42° F.

Meat was also stored in the pan below the unit of the electric refrigerator, the coldest location outside of the unit itself. It was found that the meat may or may not freeze in the pan, depending upon the temperature maintained. The meat should be wrapped or placed in a covered container.

GROUND BEEF AND PORK

Five thousand grams of ground beef from each side of the carcass were divided into ten 500-gram portions. Five of these portions were seasoned with 4.8 grams (approximately 1 teaspoonful) of salt and .5 gram (¼ teaspoonful) of pepper. The ten seasoned and the ten unseasoned portions were stored in the ice and electric refrigerators in the usual

TABLE 4. AVERAGE DAILY SHRINKAGE OF GROUND BEEF AND PORK IN ELECTRIC REFRIGERATOR.

Method of storing	Beef						Pork					
	Unseasoned			Seasoned			Unseasoned			Seasoned		
	Initial wt.	Average daily loss		Initial wt.	Average daily loss		Initial wt.	Average daily loss		Initial wt.	Average daily loss	
	gm.	gm.	%	gm.	gm.	%	gm.	gm.	%	gm.	gm.	%
Parchment and brown paper	500	11.25	2.96	507	10.05	2.48	500	7.66	2.18	504.8	6.80	1.87
Paraffin paper	500	3.25	.81	507	3.47	.89	500	2.34	.69	504.8	2.30	.60
Covered aluminum dish	500	1.15	.29	505	.95	.22	500	.74	.22	504.8	.58	.17
Covered glass dish	500	1.70	.36	507.2	1.30	.27	500	1.28	.38	504.8	.64	.17
Unwrapped	500	14.85	3.76	505	13.87	3.52	500	12.26	3.62	504.8	11.26	3.43

manner (fig. 1). The meat was weighed each day, a 75- to 100-gram portion was broiled, and the cooked and uncooked meat judged. When these tests were repeated the pepper was omitted. The ground pork was seasoned only with salt.

Tables 4 and 5 give the average daily shrinkage and percentages of loss for unseasoned and seasoned samples of ground beef and pork when stored in an ice and an electric refrigerator. In these computations as in the previous ones the percentage loss is the average of the percentages determined from day to day on the weights of ground meat remaining after samples for cooking had been removed. The results show the same general trend as those obtained with steaks and chops; the greatest loss occurred in the un-

TABLE 5. AVERAGE DAILY SHRINKAGE OF GROUND BEEF AND PORK IN ICE REFRIGERATOR.

Method of storing	Beef						Pork					
	Unseasoned			Seasoned			Unseasoned			Seasoned		
	Initial wt.	Average daily loss		Initial wt.	Average daily loss		Initial wt.	Average daily loss		Initial wt.	Average daily loss	
	gm.	gm.	%	gm.	gm.	%	gm.	gm.	%	gm.	gm.	%
Parchment and brown paper	500	10.27	2.54	505	10.40	2.59	500	7.80	2.25	504.8	6.48	1.86
Paraffin paper	500	3.42	.82	505	2.72	.73	500	3.00	.75	504.8	1.78	.49
Covered aluminum dish	500	2.00	.54	505	.95	.24	500	1.00	.27	504.8	.68	.21
Covered glass dish	500	2.00	.48	505	.95	.24	500	1.60	.42	504.8	1.00	.20
Unwrapped	500	14.32	3.81	505	12.27	3.19	500	9.84	3.11	504.8	10.30	3.07

wrapped samples, the smallest in those stored in the aluminum dish, with the others ranging between in the same order as before. With two exceptions, there was less shrinkage in the seasoned samples than in the unseasoned. The desirability of seasoning was confirmed when the portions which were made into patties and cooked each day were judged. The seasoned patties were always more moist and of fresher flavor.

Ground meat has a much larger proportion of exposed surface than other cuts, and could not be held for more than from 24 to 48 hours at temperatures above 45°. After this length of time the unseasoned samples stored in covered containers tended to be moist and slimy, and a hard dry crust had formed on the uncovered samples. This meat when cooked had an undesirable flavor. After 48 hours the samples wrapped in parchment and in wax paper were the most desirable.

The seasoned meat kept better than the unseasoned. Salt preserved the moisture in the meat, but the surface gradually acquired a slimy feel. When portions were cooked this was not noticeable, and the flavor of all of the seasoned samples was similar. The salt and herbs or spices frequently added to ground meat, especially pork, undoubtedly aid in preserving the meat, but care must be taken not to hold such meat too long, since the seasonings tend to cover up an off-flavor.

ROASTS OF BEEF, PORK AND LAMB

Roasts of beef, pork and lamb were used for a third series of tests.[2] Three pairs at a time were stored. The first set was unwrapped, the second set was wrapped in paraffin paper, and the third was placed in covered containers of glass and aluminum. The pairs were placed in the refrigerators at 24-hour intervals, so that no two pairs in one set were of exactly the same age. The roasts were weighed every day and judged for odor and appearance. The first set was cooked when the oldest roast was 72 hours old. Electric ranges were used. The roasts were seared at 500° F. for 20 minutes, the thermostat then reset at 250° F. and the cooking continued until an internal temperature of 140° F. was reached, when the roasts were removed from the ovens and weighed.[2] The internal temperature was determined by a meat thermometer inserted as nearly as possible into the center of the roast. Records were kept of the weight of drippings and of volatile loss.

[2] These tests were made before the present practice of maintaining the entire roasting process at a low temperature was recommended.

The second set was roasted when the oldest roast had been stored 120 hours, the third set when the oldest had been stored 96 hours. The variation in length of time of keeping the different sets of roasts gave a comparison between roasts kept the same length of time by different methods and also allowed the study of other factors, such as a tendency to lose excessive moisture, and the beginnings of spoilage.

After they were cooked the roasts were stored in the same manner as before. One of a pair was placed in a refrigerator while still warm, the other allowed to cool first. Each day the roasts were weighed and judged until signs of spoilage occurred, when they were discarded.

The pork loin roasts were roasted to an internal temperature of 175° F.

Only three pairs of legs of lamb were purchased. One pair of legs was wrapped in paraffin paper, a second pair was placed in covered dishes of enamelware, and a third pair was left uncovered. At the end of 5 days they were all roasted in the usual manner. They were cooked to an internal temperature of 165° F.

Tables 6 and 7 give the percentages of shrinkage and also the percentages of cooking losses in drippings and in volatile constituents of 72-hour roasts of beef, pork and lamb except that in the case of lamb the percentages of drippings and volatile elements are from 120-hour roasts, the only tests made (fig. 2). For further comparison the shrinkage and cooking losses of 120-hour roasts are given in table 8.

From tables 6 and 7 and also from the tables in the appendix it is apparent that on the whole the greatest total losses occurred with pork, the least with standing rib roasts of beef. Rolled rib roasts of beef and legs of lamb showed losses approximately half-way between the highest and lowest. Almost without exception the roasts stored unwrapped had the highest precooking shrinkage loss; those wrapped in paraffin paper were next, and the covered roasts had the least loss.

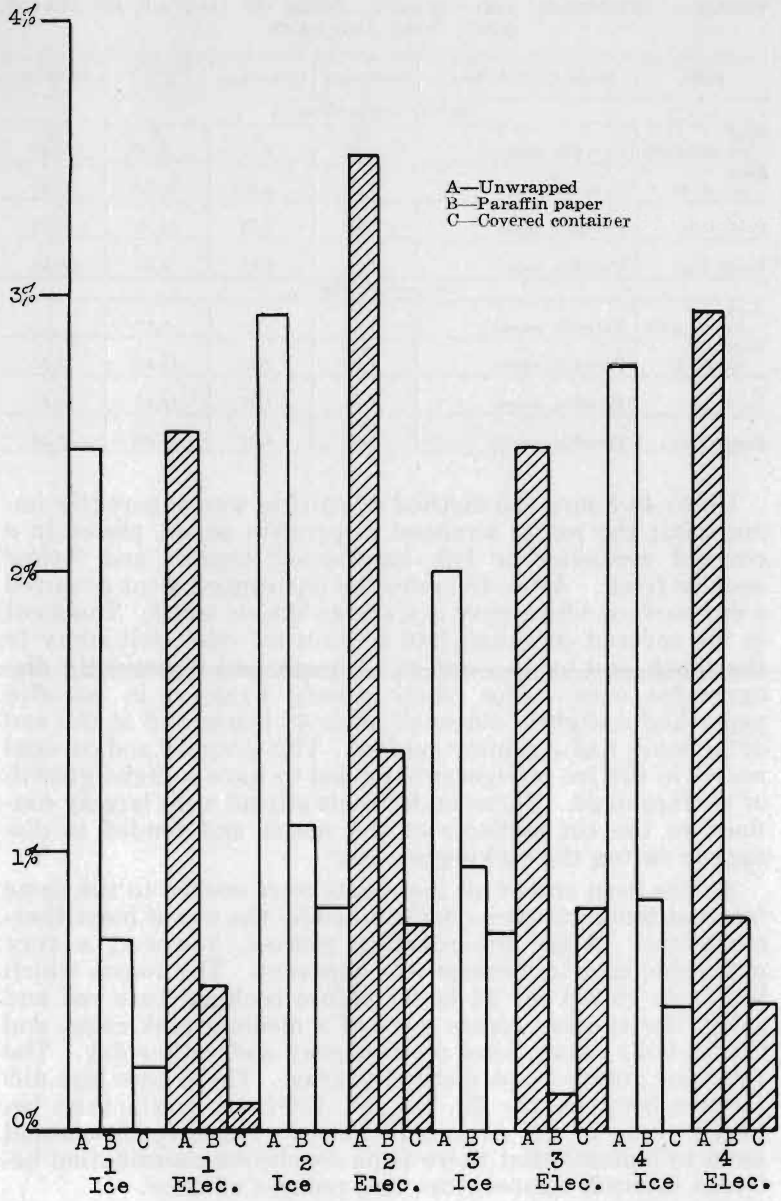
As far as keeping qualities were concerned, roasts of beef, pork and lamb behaved similarly under corresponding storage conditions. It was thought that roasts of pork with a thicker protective layer of surface fat would remain fresh longer, but this did not prove to be the case. To test this theory more completely, additional roasts of pork were stored for periods up to 14 days. Although actual spoilage did not take place the fat gradually acquired a watery, porous texture and seemed to be partly disintegrated. When cooked this fat was quite undesirable both in texture and flavor.

TABLE 6. SHRINKAGE AND COOKING LOSSES OF 72-HOUR ROASTS OF BEEF, PORK AND LAMB (ELECTRIC REFRIGERATOR).

Meat	Method of storing	Shrinkage	Drippings	Volatile loss	Total loss
		%	%	%	%
Beef standing rib	Unwrapped	2.50	8.01	7.40	17.91
	Paraffin paper	.51	2.07	11.80	14.38
	Covered container	.09	3.54	8.87	12.50
Beef rolled rib	Unwrapped	3.50	6.92	12.04	22.46
	Paraffin paper	1.37	8.88	10.34	20.59
	Covered container	.74	2.88	10.86	14.48
Pork loin	Unwrapped	2.45	18.58	13.66	34.69
	Paraffin paper	.14	15.29	10.82	26.37
	Covered container	.80	.....	.....	.....
Lamb legs	Unwrapped	2.93	(120 hr.) 9.26	(120 hr.) 7.77	(120 hr.) 21.37
	Paraffin paper	.77	(120 hr.) 9.45	(120 hr.) 9.29	(120 hr.) 20.50
	Covered container	.46	(120 hr.) 9.53	(120 hr.) 11.65	(120 hr.) 21.86

TABLE 7. SHRINKAGE AND COOKING LOSSES OF 72-HOUR ROASTS OF BEEF, PORK, AND LAMB (ICE REFRIGERATOR).

Meat	Method of storing	Shrinkage	Drippings	Volatile loss	Total loss
		%	%	%	%
Beef standing rib	Unwrapped	2.44	7.41	6.58	16.43
	Paraffin paper	.67	3.77	11.00	15.44
	Covered container	.22	4.04	8.32	12.58
Beef rolled rib	Unwrapped	2.93	4.05	14.78	21.76
	Paraffin paper	1.10	8.08	13.67	22.85
	Covered container	.80	2.38	11.99	15.17
Pork loin	Unwrapped	2.02	14.63	12.85	29.50
	Paraffin paper	.95	13.57	9.37	23.89
	Covered container	.70	11.00	16.80	28.50
Lamb legs	Unwrapped	2.76	(120 hr.) 6.12	(120 hr.) 8.40	(120 hr.) 18.85
	Paraffin paper	.83	(120 hr.) 8.37	(120 hr.) 9.64	(120 hr.) 19.24
	Covered container	.45	(120 hr.) 11.10	(120 hr.) 11.62	(120 hr.) 23.48



1. Beef standing rib. 2. Beef rolled rib. 3. Pork loin. 4. Lamb legs.

Fig. 2. Percentage of shrinkage in roasts at end of 72 hours.

TABLE 8. SHRINKAGE AND COOKING LOSSES OF 120-HOUR ROASTS OF BEEF, PORK AND LAMB.

Meat	Method of storing	Shrinkage	Drippings	Volatile loss	Total loss
		Electric refrigerator			
Beef standing rib	Paraffin paper	% 2.23	% 4.14	% 8.04	% 14.41
Beef rolled rib	Paraffin paper	1.90	2.68	12.93	17.51
Pork loin	Paraffin paper	.80	7.13	16.20	24.13
Lamb legs	Paraffin paper	1.76	9.45	9.29	20.50
		Ice refrigerator			
Beef standing rib	Paraffin paper	2.40	.....	7.55	.....
Beef rolled rib	Paraffin paper	1.70	3.53	12.83	18.06
Pork loin	Paraffin paper	1.12	4.67	14.45	20.24
Lamb legs	Paraffin paper	1.23	8.37	9.64	19.24

Up to 48 hours the method of storing was apparently immaterial; the roasts wrapped in paraffin paper, placed in a covered container or left unwrapped smelled and looked equally fresh. After 48 hours the unwrapped meat acquired a dry surface which gave it a somewhat old smell. The meat in the covered container had a "shut-in" odor, felt slimy to the touch and by the end of 72 hours had a distinctly disagreeable odor. The roasts closely wrapped in paraffin paper had a slightly old smell after 48 hours and at the end of 96 hours had a gummy surface. The wrapped and covered roasts in the ice refrigerator tended to have a slight growth of surface mold. These undesirable effects were largely confined to the cut surfaces of the meats and tended to disappear during the cooking process.

As has been stated all the roasts were cooked to the same internal temperature as determined by the use of meat thermometers. After the roasting process, however, a very noticeable color difference was apparent. The roasts which had been stored for 24 hours before cooking were red and juicy, the 48-hour roasts were of a medium pink color, and the 72-hour roasts were pinkish gray and rather dry. The 120-hour roasts were distinctly gray. There was less difference between the 72, 96 and 120-hour roasts than between those of 24, 48 and 72 hours. These results would seem to indicate that there is no conclusive coordination between internal temperature and redness of color.

Occasionally a difference in color intensity was noticed in two beef roasts which had been stored by the same method

and for the same length of time before cooking. The determining factor in these cases seemed to be the size of the roast, or the amount of fat present. Small roasts were always grayer in color, and roasts with a large proportion of fat were redder. Sayre (19) found that fat apparently possessed certain insulating qualities which hindered heat penetration. By the end of 72 hours after cooking, when the outside slices of meat had been cut away for tests, the differences in color and flavor had disappeared so that all roasts appeared similar. The roasts of pork and lamb did not show these changes to such a marked degree, because they were cooked to a higher internal temperature.

Some discussion has arisen as to whether it is desirable to place cooked meat in the refrigerator while it is still warm, or to allow it to cool first to room temperature. Table 9 shows the shrinkage for the first 24 hours and the average shrinkage over a following period of 3 days in roasts of beef and pork, some of which were put into the refrigerator while warm and others cooled first. From the data it is evident that there was greater shrinkage when the roast was cooled before being placed in the refrigerator; in other words more rapid cooling apparently retarded shrinkage. As would be expected the shrinkage was greatest, both during the first 24 hours and in the following 3 days, when the roasts were stored uncovered.

With the legs of lamb (table 10) similar results were found in the average shrinkage during the 3 days following the roasting, but in this set greatest shrinkage during the first 24 hours occurred in the roasts wrapped in paraffin paper. A large amount of juice was found on the paraffin

TABLE 9. SHRINKAGE LOSSES OF 72-HOUR COOKED ROASTS OF BEEF AND PORK, PLACED IN REFRIGERATOR WHEN WARM AND WHEN COLD.

Meat	Method of storage	Condition when placed in refrigerator	Shrinkage (1st 24 hours)	Average shrinkage (3 days following)
			gm.	gm.
Beef standing rib	Unwrapped	Warm	36.9	17.0
		Cold	45.8	15.7
	Covered container	Warm	7.8	1.7
		Cold	8.0	2.7
Beef rolled rib	Paraffin paper	Warm	8.0	1.6
		Cold	20.0	2.0
	Covered container	Warm	9.1	0.2
		Cold	13.8	0.4
Pork loin	Paraffin paper	Warm	6.8	2.8
		Cold	25.1	3.1
	Covered container	Warm	7.1	2.5
		Cold	12.0	2.0 (2 days)

TABLE 10. SHRINKAGE OF 120-HOUR LEGS OF LAMB PLACED IN REFRIGERATOR WHEN WARM.

Refrigerator	Method of storage	Shrinkage (1st 24 hours)	Average shrinkage (3 days following)
		gm.	gm.
Electric	Unwrapped	27.1	19.5
	Paraffin paper	74.7	7.1
	Covered container	28.7	4.5
Ice	Unwrapped	33.3	21.1
	Paraffin paper	44.1	8.5
	Covered container	20.0	4.3

paper when the lamb was unwrapped the second day. The legs had been wrapped completely and tightly which may have slowed up the cooling process. The enamelware pans, in which the covered lamb was stored, were perforated to allow some slight circulation of air, which would cause more rapid cooling (fig. 3).

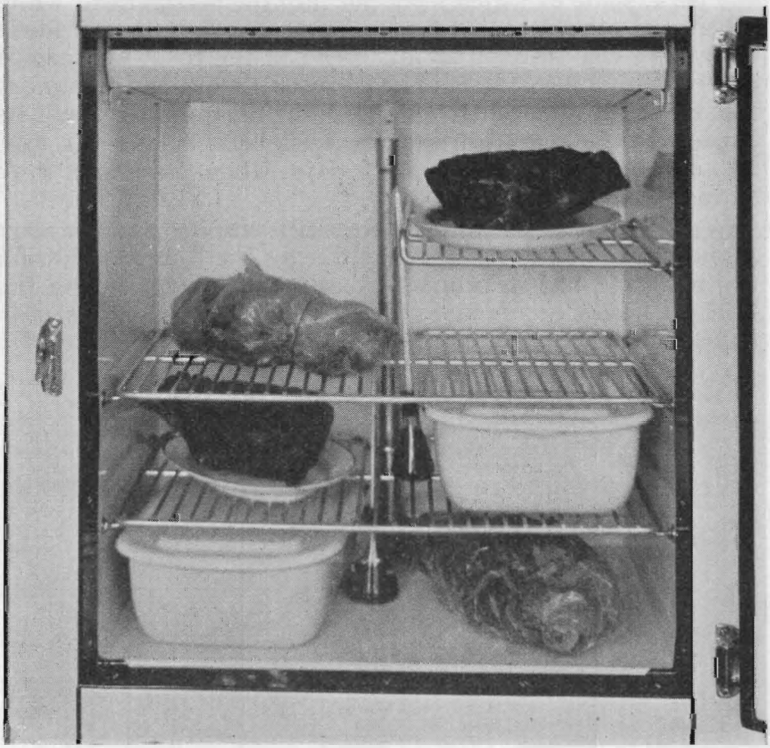


Fig. 3. Legs of lamb stored unwrapped, wrapped in paraffin paper, and in covered containers.

Although data are given for only a 4-day period of storage, most of the roasts were held longer, frequently a week, and in other cases 10, 12, and the unwrapped pork loins even 18 days. Roasts were discarded when they became too dry to be desirable for eating, if they had not shown signs of deterioration previously. As has been noted, after the first 2 or 3 days of sampling, as the center of the roast was reached, differences in color, moistness and flavor tended to disappear. For this reason, it was possible to select one or two roasts from a set for longer storage and discard the others. Such a procedure was occasionally necessary because of the limited storage space.

The unwrapped roasts tended to become dry on the surface as the storage period continued. This was especially noticeable with beef, and less so with pork, presumably because of the larger amount of surface fat present.

The beef which was wrapped or stored in covered containers kept satisfactorily for 5 or 6 days. After this time it became slightly slimy to the touch and acquired a sour odor. When the outer surface was cut away the inner slices were still desirable. There was no appreciable difference in the flavor of the meat stored while warm and that which was allowed to cool first.

The cooked rolled rib roasts of beef were usually not so red in color as the standing rib roasts. The shrinkage which occurred in the rolled roasts during the first 24 hours of storage seemed to be caused largely by loss of juices rather than volatile matter, since a noticeable amount of juice collected in the containers. This loss varied with the age of the roast before cooking, the largest amount being lost from the oldest roast in each series and the least from the one stored for the shortest period of time. The smaller volumes of juice were always much richer in quality. Table 11 summarizes some of these results. Because of the tendency to

TABLE 11. SHRINKAGE LOSSES OF COOKED ROLLED RIB ROASTS OF BEEF PLACED IN THE REFIGERATOR WHEN WARM.

Method of storage	Time stored before roasting	Shrinkage (1st 24 hours after roasting)
	hr.	gm.
Unwrapped	24	11.1
	48	21.6
	72	25.1
Paraffin paper	72	8.0
	96	10.4
	120	37.9
Covered container	48	4.9
	72	9.1
	96	17.3

Fig. 4. Pork loin roasts.

lose juice the rolled roasts lost their red color during storage and became gray.

The pork loin roasts remained fresh longer than the beef, but after 12 days mold gradually formed on the surfaces from which no daily samples were cut. The unwrapped roasts were desirable for the 18 days they were stored even at a temperature of 48° F. Those with small amounts of fat were somewhat dry, but not unpalatable (fig. 4).

The legs of lamb stored in paraffin paper and in covered containers acquired an old taste and odor after 72 hours. The unwrapped legs were rather dry and tasteless at the end of 7 days. Lamb, like beef, could not be stored for as long a period as could pork (fig. 5).

As a result of these tests it was concluded that cooked roasts of beef, pork and lamb may be stored satisfactorily

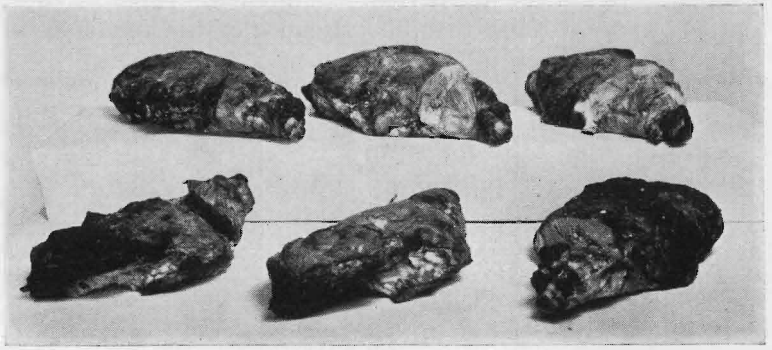


Fig. 5. Leg of lamb roasts.

from 2 to 3 days at temperatures of 48° F. or below, when wrapped in paraffin paper or placed in a perforated covered container. For longer storage periods the meat should be left unwrapped or wrapped loosely in paraffin paper. When held for 6 days or longer the storage temperature should be below 45° F., except in the case of pork roasts with a thick layer of surface fat. Such roasts may be held at 48° F., if necessary.

HAM AND BACON

Slices of ham and whole hams were stored in the following ways: The slices were wrapped in paraffin paper, placed in covered glass dishes and left unwrapped; the whole hams were wrapped in parchment paper, wrapped in paraffin paper and left unwrapped. Storage methods which were readily available to the housewife were used. The hams were too large to be stored in covered containers of a size commonly obtainable.

Packaged bacon was stored in the original paraffin wrapping, was removed from the wrapping and wrapped in parchment paper, and was placed in a covered glass container. Additional packages of bacon in the original wrapping were stored in the refrigerators, from which only the slices to be cooked were removed. In the other cases the whole package was removed, the slices taken out as the cooking process was carried on, and the unused portion then returned. Bacon by the piece was wrapped in parchment paper, wrapped in paraffin paper and left unwrapped. Three additional squares of bacon, wrapped in parchment and paraffin papers and left

TABLE 12. AVERAGE DAILY SHRINKAGE LOSSES OF HAMS, STORED IN ELECTRIC AND ICE REFRIGERATORS AND AT ROOM TEMPERATURE FOR 25 DAYS.

Type of storage	Method of storage	Initial wt.	Average daily loss (25 days)		Average daily loss (32 days)	
		gm.	gm.	%	gm.	%
Elec. refrig.	Unwrapped	2232.1	10.8	.48	9.6	.43
	Paraffin paper	2376.5	4.6	.19		
	Parchment paper	2673.5	7.9	.29		
Ice refrig.	Unwrapped	2046.4	9.9	.48	8.8	.43
	Paraffin paper	2334.7	4.6	.19		
	Parchment paper	2495.3	8.3	.33		
Room temp.	Unwrapped	2821.3	13.0	.46		
	Paraffin paper	2869.8	11.0	.38		
	Parchment paper	2695.6	12.3	.45		

unwrapped, and one package of sliced bacon in the original wrapping were stored at room temperature.

Hams were stored in the electric and ice refrigerators from 25 to 32 days. They were also stored for 25 days at room temperature. The shrinkage losses, given in table 12, were small with all the storage methods used.

Wrapped hams gradually acquired a mold, and the cut surfaces of those in paraffin paper were moist and tended to be slimy. Although the mold could be wiped off and at first did not seem to affect the taste, toward the end of the test period the mold gave the cooked ham a slightly musty, undesirable flavor. The hams held at 45° F., or below, were of better odor and flavor than those stored at temperatures above 45° F. At the higher temperatures mold formed on the uncut surfaces. Regardless of temperature there was a gradual deposit of the salt used in the curing process on the surface of the hams left unwrapped. To get rid of this excess salt it was necessary to parboil the slices before cooking them.

TABLE 13. AVERAGE DAILY SHRINKAGE LOSSES OF SLICES OF HAM, STORED IN ELECTRIC AND ICE REFRIGERATORS FOR 14 DAYS.

Refrigerator	Method of storage	Initial wt.	Average daily loss	
		gm.	gm.	%
Electric	Unwrapped	475.0	6.10	1.28
	Paraffin paper	425.7	3.60	.84
	Covered container	403.0	0.18	.04
Ice	Unwrapped	513.7	7.50	1.46
	Paraffin paper	491.9	3.60	.73
	Covered container	529.1	0.25 (9 days)	.05 (9 days)

The samples stored at room temperature also became moldy, and the unwrapped ones became dry and salty. The fat disintegrated slightly, and drops of oil appeared on the surface.

If ham is to be stored for longer than 2 weeks it seems preferable to store it unwrapped at temperatures below 45°. It should then be parboiled before the final cooking.

Similar results were obtained with the slices of ham. Table 13 gives the shrinkage losses. In one case deterioration occurred in 9 days, as indicated in the table. It was concluded that a slice of ham, held from 7 to 10 days, may be placed in a covered container or wrapped in paraffin paper and should be stored at 45° F. or below. When the ham was held for a longer period or at higher temperatures, leaving it unwrapped was preferable, but parboiling was then necessary.

TABLE 14. AVERAGE DAILY SHRINKAGE LOSSES OF SLICED BACON, STORED IN ELECTRIC AND ICE REFIGERATORS AND AT ROOM TEMPERATURE FOR 30 DAYS.

Type of storage	Method of storage	Initial wt.	Average daily loss	
		gm.	gm.	%
Elec. refrig.	Original paraffin wrapping	229.5	.89	.39
	Parchment	212.8	.70	.33
	Glass container	218.2	.09	.04
Ice refrig.	Original paraffin wrapping	224.5	.60	.27
	Parchment	229.3	.48	.21
	Glass container	208.5	.11	.05
Room temp.	Original paraffin wrapping	231.5	1.23	.53

Sliced bacon and uncut bacon squares were stored by the methods indicated in tables 14 and 15, and with the shrinkage losses recorded. Although not indicated in the table, the greatest shrinkage occurred during the first week and gradually decreased to a negligible amount during the fourth week.

For the first 2 weeks of the period the storage methods used were about equally desirable, even at refrigerator temperatures of 48° F., although the bacon held at the higher temperature was slightly less firm in texture. There was, however, no difference in flavor after broiling. For storage longer than 2 weeks the glass container was preferable at temperatures below 45° F.; otherwise, the original paraffin

TABLE 15. AVERAGE DAILY SHRINKAGE LOSSES OF SQUARES OF BACON STORED IN ELECTRIC AND ICE REFRIGERATORS AND AT ROOM TEMPERATURE FOR 30 DAYS.

Type of storage	Method of storage	Initial wt.	Average daily loss	
		gm.	gm.	%
Elec. refrig.	Unwrapped	602.1	1.8	.30
	Paraffin paper	606.3	1.2	.20
	Parchment paper	645.5	1.7	.26
Ice refrig.	Unwrapped	607.5	1.7	.28
	Paraffin paper	579.3	1.1	.19
	Parchment paper	580.4	1.4	.24
Room temp.	Unwrapped	589.8	(14 days) 4.6	.78
	Paraffin paper	759.6	(14 days) 2.8	.37
	Parchment paper	758.0	2.9	.38

wrapping was better. At room temperatures the best results were obtained when the bacon was wrapped in parchment paper, but even under these conditions the fat became soft, much oil seeped on to the wrappings, and some mold formed on the surface. The bacon also gradually acquired a strong, smoky odor. The packaged bacon showed less tendency to mold than did the bacon squares.

As was noted in the method of procedure, one package of sliced bacon was never taken from the refrigerator, but only the slices desired for cooking were removed from time to time. This method prevented any softening of the fat in the bacon which was not cooked, a condition which tended to occur when the whole package was removed and allowed to stand at room temperature while the selected slices were being cooked.

SAUSAGE

Sausages in casings were purchased in bulk and in package form and were stored as purchased, i.e., in the package or on a plate. They were also wrapped in parchment paper and placed in covered glass containers. Pork sausage in bulk, purchased as prepared with salt and herbs, was stored wrapped in paraffin paper, in parchment paper and left unwrapped.

TABLE 16. AVERAGE DAILY SHRINKAGE LOSSES OF SAUSAGE IN CASINGS (PURCHASED IN PACKAGE AND IN BULK) AND OF GROUND PORK SAUSAGE MEAT (STORED 9 DAYS).

Type of storage	Meat	Method of storage	Initial wt.	Average shrinkage per day	
			gm.	gm.	%
Electric refrigerator	Sausage in casings (packaged)	Unwrapped	462.3	3.70	.80
		Parchment paper	478.2	3.31	.69
		Glass container	475.8	0.44	.09
	Sausage in casings (bulk)	Unwrapped	468.4	6.54	1.39
		Parchment paper	479.1	5.30	1.13
		Glass container	353.0	0.53	.15
	Ground pork sausage	Unwrapped	400.0	5.66	1.42
		Parchment paper	400.0	5.23	1.31
		Paraffin paper	400.0	2.69	.67
Ice refrigerator	Sausage in casings (packaged)	Unwrapped	472.9	4.40	.93
		Parchment paper	457.8	2.73	.59
		Glass container	497.1	0.31	.06
	Sausage in casings (bulk)	Unwrapped	457.5	5.84	1.28
		Parchment paper	461.4	4.41	.95
		Glass container	408.3	0.37	.09
	Ground pork sausage	Unwrapped	400.0	5.55	1.39
		Parchment paper	400.0	6.38	1.59
		Paraffin paper	400.0	2.59	.65

TABLE 17. AVERAGE DAILY SHRINKAGE LOSSES OF DRIED BEEF STORED 30 DAYS.

Type of storage	Method of storage	Initial wt.	Average daily loss	
		gm.	gm.	%
Electric refrig.	Paraffin paper	125	.82	.66
	Parchment paper	125	1.13	.90
	Glass container	125	.10 (9 days)	.08
Ice refrig.	Paraffin paper	125	.77	.62
	Parchment paper	125	1.29	1.03
	Glass container	125	.05	.04

Table 16 gives the average daily shrinkage losses of pork sausage meat in casings and ground in bulk. The ground meat sustained the greatest loss during storage and the sausage in casings, purchased unpackaged, the next highest.

Sausages in casings were stored most satisfactorily when wrapped loosely in parchment paper. If purchased in package form and held for more than 4 days, sausages should be removed from the package, separated, and then wrapped in parchment paper. When left in the package for a longer period, moisture formed between the closely packed casings

TABLE 18. AVERAGE DAILY SHRINKAGE LOSSES OF READY-TO-SERVE MEATS STORED IN ELECTRIC REFRIGERATOR.

Meat	Method of storage	Initial wt.	Average daily loss	
		gm.	gm.	%
Chicken loaf	Unwrapped	178	7.97	4.48
	Parchment paper	200	4.74	2.37
	Paraffin paper	200	1.10	.55
	Glass container	200	0.46	.23
Boiled ham (sliced)	Unwrapped	200	5.11	2.55
	Parchment paper	200	3.11	1.55
	Paraffin paper	200	2.39	1.14
	Glass container	200	0.03	.01
Spiced loaf	Unwrapped	200	7.45	3.72
	Parchment paper	200	5.26	2.63
	Paraffin paper	200	2.91	1.45
	Glass container	200	0.14	.07
Boiled tongue (sliced)	Unwrapped	200	7.89	3.94
	Parchment paper	200	5.44	2.72
	Paraffin paper	200	1.92	.96
	Glass container	200	0.40	.20

and mold formed. When cooked the packaged sausages were better flavored and more crisp than those purchased in bulk. If the sausages were held for more than 7 or 8 days, a temperature of 45° F. or below was desirable.

The ground sausage meat should be stored at 45° F. or below if held for more than 3 days. It was stored most satisfactorily in wax paper. It stuck to the parchment paper and rapidly acquired a dry crusty surface and an old odor and flavor when stored uncovered.

DRIED BEEF

The sliced dried beef was stored in the refrigerators in glass and wrapped in paraffin and in parchment papers. When dried beef was stored in a covered container, the daily average shrinkage loss was so slight that it was considered negligible (table 17).

It was stored in this way at 42° F. or below from 3 to 4 weeks and remained desirable in flavor. The samples stored in parchment became dry after about 2 weeks, and the curing salt crystallized on the edges of the slices. When wrapped

TABLE 19. AVERAGE DAILY SHRINKAGE LOSSES OF READY-TO-SERVE MEATS STORED IN ICE REFRIGERATOR.

Meat	Method of storage	Initial wt.	Average daily loss	
		gm.	gm.	%
Chicken loaf	Unwrapped	200	8.12	4.06
	Parchment paper	200	4.66	2.33
	Paraffin paper	200	1.94	.97
	Glass container	200	0.32	.16
Boiled ham (sliced)	Unwrapped	200	8.08	4.04
	Parchment paper	200	4.42	2.21
	Paraffin paper	200	1.60	.80
	Glass container	200	0.74	.37
Spiced loaf	Unwrapped	200	8.72	4.36
	Parchment paper	200	6.08	3.04
	Paraffin paper	200	2.22	1.11
	Glass container	200	0.12	.06
Boiled tongue (sliced)	Unwrapped	200	8.72	4.36
	Parchment paper	200	5.60	2.80
	Paraffin paper	200	1.96	.98
	Glass container	200	0.20	.10

in paraffin paper the beef dried slightly, and some salt appeared on the exposed surfaces.

READY-TO-SERVE MEATS

The final experiments were with some of the ready-to-serve meats. Chicken loaf, sliced boiled ham, spiced loaf (principal ingredient was ground pork), and boiled tongue were selected. These meats were stored uncovered, stored in covered glass containers, wrapped in paraffin paper, and wrapped in parchment paper.

The tests were carried on in July, a time when such cooked meats are most likely to be used in the home. The room temperature averaged approximately 82° F., but one day it registered as high as 86° F. The temperature in the ice refrigerator remained between 48° and 49° F. None of the samples stored in the refrigerator were desirable after 72 hours, and the portions stored in the covered containers had molded before that time.

The paraffin and parchment papers offered the most desirable methods of storing, but after 4 or 5 days, even at a temperature of 42° F., the cut surfaces of the different samples acquired a slimy texture, and mold appeared on the tongue. The tongue and chicken showed signs of spoilage first. The somewhat greater resistance of the ham and spiced loaf to deterioration was doubtless due to the cured condition of the ham and the preservative quality of the spices. The unwrapped meat became dry, and with the evaporation of the moisture the flavor was distinctly salty. Although the tests were continued from 7 to 10 days, it is doubtful if the homemaker would store meat of this type for longer than 24 to 48 hours.

The average daily shrinkage losses are given in tables 18 and 19.

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APPENDIX

TABLE 20. SHRINKAGE AND COOKING LOSSES OF ROASTS OF BEEF, PORK AND LAMB (ELECTRIC REFRIGERATOR).

Meat	Method of storing	Time stored	Initial weight	Shrinkage	Drippings	Volatile loss	Total loss
		hrs.	gm.	%	%	%	%
Beef standing rib	Unwrapped	24	2056.9	0.90	3.45	7.65	12.00
	"	48	2019.8	2.04	5.19	7.16	14.39
	"	72	2067.2	2.50	8.01	7.40	17.91
	Paraffin paper	72	1961.0	0.51	2.07	11.80	14.38
	" "	96	1774.8	1.14	1.67	9.02	11.83
	" "	120	1432.0	2.23	4.14	8.04	14.41
	Covered container	48	1778.5	0.53	5.74	11.35	17.62
	" "	72	1427.7	0.09	3.54	8.87	12.50
	" "	96	1295.8	0.48	6.65	7.39	14.52
Beef rolled rib	Unwrapped	24	1043.8	1.19	6.36	15.11	22.66
	"	48	1369.9	2.05	.....	.....	.....
	"	72	1646.8	3.50	6.92	12.04	22.46
	Paraffin paper	72	1423.9	1.37	8.88	10.34	20.59
	" "	96	1776.5	1.72	3.90	13.23	18.85
	" "	120	2273.6	1.90	2.68	12.93	17.51
	Covered container	48	1502.9	0.88	5.93	11.54	18.35
	" "	72	1542.4	0.74	2.88	10.86	14.48
	" "	96	2008.2	0.81	1.57	11.50	13.88
Pork loin	Unwrapped	24	1357.0	1.20	10.68	13.66	25.54
	"	48	1710.9	1.92	11.84	8.56	22.32
	"	72	1909.3	2.45	18.58	13.66	34.69
	Paraffin paper	72	1584.4	0.14	15.29	10.82	26.37
	" "	96	1727.4	0.66	8.32	16.48	25.46
	" "	120	2154.9	0.80	7.13	16.20	24.13
	Covered container	48	1766.5	0.40			
	" "	72	1869.9	0.80	error in data		
	" "	96	1996.4	0.53			
Lamb leg	Unwrapped	120	2764.5	4.34	9.26	7.77	21.37
	Paraffin paper	120	2941.1	1.76	9.45	9.29	20.50
	Covered container	120	2473.3	.68	9.53	11.65	21.86

TABLE 21. SHRINKAGE AND COOKING LOSSES OF ROASTS OF BEEF, PORK AND LAMB (ICE REFRIGERATOR).

Meat	Method of storing	Time stored	Initial weight	Shrinkage	Drippings	Volatile loss	Total loss
		hrs.	gm.	%	%	%	%
Beef standing rib	Unwrapped	24	2215.4	.66	2.74	8.95	12.35
	"	48	2155.7	2.03	6.29	7.52	15.84
	"	72	2024.9	2.44	7.41	6.58	16.43
	Paraffin paper	72	2072.2	0.67	3.77	11.00	15.44
	" "	96	1813.5	1.27	2.35	9.32	12.94
	" "	120	1705.6	2.40	.....	7.55	.....
	Covered container	48	1921.9	0.15	5.41	11.25	16.81
	" "	72	1543.8	0.22	4.04	8.32	12.58
	" "	96	1314.6	0.91	.....	.....	Discarded before cooking
Beef rolled rib	Unwrapped	24	1162.9	1.04	7.49	13.27	21.80
	"	48	1527.7	1.87	4.85	11.62	18.34
	"	72	1667.7	2.93	4.05	14.78	21.76
	Paraffin paper	72	1389.5	1.10	8.08	13.67	22.85
	" "	96	1537.9	1.36	3.85	13.03	18.24
	" "	120	2185.9	1.70	3.53	12.83	18.06
	Covered container	48	1401.4	0.87	6.25	12.97	20.09
	" "	72	1582.8	0.80	2.38	11.99	15.17
	" "	96	1987.0	0.53	3.84	11.03	15.40

TABLE 21. SHRINKAGE AND COOKING LOSSES OF ROASTS OF BEEF, PORK AND LAMB (ICE REFRIGERATOR).—Continued.

Meat	Method of storing	Time stored	Initial weight	Shrinkage	Drippings	Volatile loss	Total loss
		hrs.	gm.	%	%	%	%
Pork loin	Unwrapped	24	1313.1	1.11	11.91	13.05	26.07
	"	48	2128.2	1.74	15.29	8.73	25.76
	"	72	2004.3	2.02	14.63	12.85	29.50
	Paraffin paper	72	1358.3	0.95	13.57	9.37	23.89
	" "	96	1742.2	0.63	10.40	13.01	24.04
	" "	120	1694.9	1.12	4.67	14.45	20.24
	Covered container	48	1529.6	0.49	14.83	11.95	27.27
	" "	72	1976.3	0.70	11.00	16.80	28.50
	" "	96	1725.8	0.88	9.10	11.74	21.72
Lamb leg	Unwrapped	120	2843.2	4.33	6.12	8.40	18.85
	Paraffin paper	120	2965.2	1.23	8.37	9.64	19.24
	Covered container	120	2508.1	0.76	11.10	11.62	23.48

TABLE 22. HISTORY AND GRADING OF MEAT USED IN TESTS.

Date killed	Date furnished	Carcass weight (lbs.)	Cut furnished	Weight of cut (lbs.)	Grade
			Beef		
2/2/34	2/12/34	480	2 beef rounds	151	Medium
2/2/34	2/19/34	480	Ground beef	24	Medium
2/2/34	2/26/34	480	Beef rib	41½	Medium
2/23/34	3/1/34	404	Beef rib	33	Medium
2/23/34	3/6/34	380	Beef rib	31	Medium
2/27/34	3/5/34	400	Loin steaks	8	Medium
2/27/34	3/12/34	390	Loin steaks	8	Medium
3/9/34	3/19/34	500	Beef round	75	Good
3/9/34	3/27/34	500	Ground beef	24	Good
4/14/34	4/30/34	532	Beef rib	29½	Good
5/1/34	5/3/34	380	Beef rib	34	Medium
5/2/34	5/8/34	410	Beef rib	34½	Good
			Pork		
3/28/34	4/2/34	174	Pork loin	23½	Choice
4/3/34	4/9/34	174			
		176			
		170	Pork loin	49	Choice
4/10/34	4/12/34	176	Pork loin	24	Choice
4/18/34	4/23/34	186	Ground pork	24	Choice
			Lamb		
5/8/34	5/13/34	55	Lamb chops	8	Choice
	5/23/34		Lamb legs	7 pounds each	Choice-prime